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RELATED PATENTS

This patent stems from a continuation-in-part patent application of U.S. patent application serial no. 09/181,724, filed November 29, 1998 entitled MATCHED-FILTER BASED HANDOFF METHOD AND APPARATUS, now U.S. patent no. 6,215,811, which is a continuation application of U.S. patent application serial no. 08/638,394, filed April 29, 1996, entitled MATCHED FILTER-BASED HANDOFF METHOD AND APPARATUS, now U.S. patent no. 5,864,578. The benefit of the earlier filing dates of the parent patent applications are claimed for common subject matter pursuant to 35 U.S.C. § 120.

BACKGROUND OF THE INVENTION

This invention relates to spread-spectrum communications, and more particularly to a method and apparatus for handing-off a remote station between two base stations.

DESCRIPTION OF THE RELEVANT ART

A spread-spectrum communications system uses message data. Message data requires transmission without error. When a mobile station moves from a source-base station to a target-base station, the chip sequence used for the channel containing the digital data has to be handed-off so as to not interrupt communications so as to produce errors.

Multiple coverage areas are employed by mobile communications systems to accommodate communications over a wide geographic region. Each geographic area has several base



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matched filter;

FIG. 4 is an example of an output signal from the frame-matched filter;

FIG. 5 illustrates an approach to finding a correct time instant at which to measure an output of a simple-matched filter;

FIG. 6 illustrates a matched filter having register and adder;

FIG. 7 illustrates a frequency response curve demonstrating that sampling may not occur at a chip peak;

FIGS. 8 and 9 illustrate selection of the correct time to yield the largest output;

FIG. 10 illustrates an example of packets for time division duplex;

FIG. 11 illustrates switch time;

FIGS. 12-20 illustrate frequency division duplex examples;

FIG. 21 illustrates adder gates;

FIG. 22 illustrates a remote station handing off between two base stations;

FIG. 23 is a block diagram of a mobile station;

FIG. 24 is a block diagram of a receiver and transmitter for handoff for a base station or a remote station;

FIG. 25 is a timing diagram for the handoff process using code multiplexing; and

FIG. 26 is a timing diagram for the handoff process using a higher symbol rate.

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circulator 310, a receiver radio frequency (RF) section 311, a local oscillator 313, a quadrature demodulator 312, and an analog-to-digital converter 314. The receiver RF section 311 is coupled between the circulator 310 and the quadrature demodulator 312. The quadrature demodulator is coupled to the local oscillator 313 and to the analog to digital converter 314. The output of the analog-to-digital converter 314 is coupled to a programmable-matched filter 315.

A preamble processor 316, pilot processor 317 and data-and-control processor 318 are coupled to the programmable-matched filter 315. A controller 319 is coupled to the preamble processor 316, pilot processor 317 and data-and-control processor 318. A de-interleaver 320 is coupled between the controller 319 and a forward-error-correction (FEC) decoder 321.

The BS spread-spectrum transmitter includes a forward-error-correction (FEC) encoder 322 coupled to an interleaver 323. A packet formatter 324 is coupled through a multiplexer 521 to the interleaver 323, and to the controller 319. A preamble generator 525 is coupled through the multiplexer 521 to the to the packet formatter 324.

A variable gain device 325 is coupled between the packet formatter 324 and a product device 326. A spreading-sequence generator 327 is coupled to the product device 326. A digital-to-analog converter 328 is coupled between the product device 328 and quadrature modulator 329. The quadrature modulator 329



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from the remote station to the target-base station. The second RS data rate is greater than the first RS data rate. Thus, the queued RS data is to the target-base station. FIG. 25 shows the second data rate, by way of example, transmitting two from a of data at the same time. The two frames of data could be transmitted over parallel channels, and at a higher data rate over a single channel.

Similarly, the queued BS data are transmitted at a second BS data rate from the target-base station to the remote station. The queued BS data are transferred at a second BS data rate. The second BS data rate is greater than the first BS data rate. The second BS data rate and second RS data rate may be greater than the first BS data rate and the first RS data rate, respectively, due to sending packets at a higher data rate, or due to using parallel spread-spectrum channels, to effectively realize a faster data rate.

After the queued RS data are transferred, the method then resumes at the first RS data rate, by transmitting, from the remote station to the target-base station, in response to the queued RS data being transferred to the target-base station, at the first RS data rate. Similarly, in response to the queued BS data being transferred to the remote station, the steps include transmitting, from the target-base station to the remote station, at the first BS data rate.

Upon handoff, the target base station is synchronized in the remote station.